

NASA Marshall Space Flight Center
Engineering Services & Science Capability Augmentation (ESSCA)
Contract 80MSFC18C0011



DEFENSE LOGISTICS AGENCY
LAND AND MARITIME
POST OFFICE BOX 3990
COLUMBUS, OH 43218-3990

**NASA - DLA Land And
Maritime Survey of Qualified Product List
Manufacturers to Understand
Barometric Pressure Testing Electrical
Biasing Conditions**

Report No.: JPID-FY22-000429

Prepared by:

Authors:

**Benny Damron, JSEG/ NASA MSFC
Jason Hochstetler, DLA Land and Maritime VAC**

February 15, 2022

- I. Purpose: NASA Marshall Space Flight Center (MSFC) in collaboration with DLA Land and Maritime-VAC support is conducting a survey to obtain feedback on the device electrical bias procedures specified in method 1001 of MIL-STD-750-1, Barometric Pressure (reduced)'. The purpose of this survey is to obtain input from the DLA Land and Maritime qualified manufacturer community to determine whether additional bias details or information should be specified within the test method. The survey results will be used to improve any test method deficiencies and result in consistent test results.
- II. Background: The purpose of the test method is to test the devices under conditions simulating the low pressure encountered in the non-pressurized portions of aircraft in high altitude flight. It is described as a way to determine the ability of electronic component parts and materials to avoid dielectric-withstanding-voltage (DWV) failures due to lowered insulating strength of air and other insulating materials during operation at reduced barometric pressure.

Infineon personnel provided a briefing to the September 2021 JEDEC MIL-STD-750 Test Methods Task Group meeting attendees regarding a possible test method requirement conflict with respect to electrical biasing in the test method. Infineon personnel identified this issue impacting MIL-STD-750 method 1001 and MIL-STD-883 method 1001.

The presentation showed that there are two statements of purpose in this test method. Paragraph 1.0 'Purpose' states that this test is intended primarily to determine device dielectric withstanding voltage. Paragraph 3.0 'Procedure' specifies that the device shall be biased at maximum rated voltage under rated atmospheric conditions if no bias conditions are specified in the applicable performance specification sheet.

The test method does not include additional details regarding how the bias voltage is applied and this has led to questions on whether test method needs clarification or additional details added to the procedure and measurement requirements.

NASA and DLA Land and Maritime are requesting all qualified manufacturers review and respond to the survey questions. The following is a brief description of the attachments:

Attachment 1 is the current revision of MIL-STD-750-1, Test Method 1001, Barometric Pressure (reduced).

Attachment 2 is the Infineon presentation, Discussion of Barometric Pressure Test Bias Conditions

1. Does your company perform testing as per MIL-STD-750-1, Test Method 1001? Please provide detailed information on how this test is performed.
2. Does your company utilize an outside test laboratory to perform this testing? If so, please identify the company and test laboratory performing this test.
 - a) If available, please provide information that details how the outside test laboratory performs this test?
3. Should clarification be added to the test method to specify whether the voltage should be applied between biased terminals in a manner as a DWV test (method 1081 of MIL-STD-750) or be applied in a case to biased terminals manner consistent with the device usage within a circuit/system (e.g. between Drain and Source for a MOSFET)?
4. Should device bias testing at maximum voltage under rated conditions be performed as part of this test method in order to comply with the procedure paragraph?
5. Should the test method specify additional information for different package types and for specific pin/lead configurations using isolated versus non-isolated packages as an example?
6. Should both DWV and biased testing be performed as part of this method? Please provide rationale why one method is preferred over the other method if only one method is to be performed.
7. Should the method distinguish separate bias conditions for isolated and non isolated packages?

III. Results: All responses to this survey shall be submitted within 45 days from the date of this email letter. Please submit all responses for this survey to: Benny.Damron@nasa.gov and copy Jason.Hochstetler@dla.mil.

IV. Conclusion: Survey results will be compiled and a summary report will be generated and submitted to the JC13.1 MIL-STD-750 Test Methods Task Group and DLA for further review and discussion.

MIL-STD-750-1A
W/CHANGE 3

METHOD 1001.4

BAROMETRIC PRESSURE (REDUCED)

1. **Purpose.** The purpose of this test method is to check the semiconductor device capabilities under conditions simulating the low pressure encountered in the nonpressurized portions of aircraft in high altitude flight. This test is intended primarily to determine the ability of component parts and materials to avoid dielectric-withstanding-voltage failures due to the lowered insulating strength of air and other insulating materials at reduced pressures. Even when low pressures do not produce complete electrical breakdown, corona and its undesirable effects, including losses and ionization, are intensified. The simulated high-altitude conditions of this test can also be employed to investigate the influence on components' operating characteristics, or other effects of reduced pressure, including changes in dielectric constants of materials, and decreased ability of thinner air to transfer heat away from heat-producing components.

2. **Apparatus.** The apparatus used for the barometric-pressure test shall consist of a vacuum pump and a suitable sealed chamber having means for visual observation of the device under test when necessary. A suitable pressure indicator shall be used to measure the simulated altitude in feet in the sealed chamber. A microammeter or oscilloscope capable of detecting specified current.

3. **Procedure.** The devices shall be mounted in the test chamber as specified and the pressure reduced to the value indicated in one of the following test conditions, as specified. Previous references to this test method do not specify a test condition; in such cases, test condition B shall be used. While the devices are maintained at the specified pressure, and after sufficient time has been allowed for all entrapped air in the chamber to escape, the devices shall be subjected to the specified test. If not specified in the applicable performance specification sheet or acquisition sheet, the device shall be subjected to the maximum voltage under rated conditions.

Test condition	Pressure – maximum		Altitude	
	Inches of mercury	Millimeters of mercury	Feet	Meters
A	8.88	226.00	30,000	9,144
B	3.44	87.00	50,000	15,240
C	1.31	33.00	70,000	21,336
D	0.315	8.00	100,000	30,480
E	0.043	1.09	150,000	45,720
F	17.300	439.00	15,000	4,572
G	9.436×10^{-8}	2.40×10^{-6}	656,000	200,000

In addition the following is required:

- a. Twenty minutes before and during the test, the test temperature shall be $+25^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- b. The specified voltage shall be applied and monitored over the range from atmospheric pressure to the specified minimum pressure and returned so that any device malfunctions, if they exist, will be detected.

3.1 **Measurement.** The device shall be connected for measurement and have the specified voltages applied during the entire pump-down cycle. The device shall be monitored with a microammeter, oscilloscope, or curve tracer for corona currents. Provision shall be made for calibrating the current flow in the test circuit minus the device under the applicable test conditions to ensure the test readings are characteristic of the device under test.

MIL-STD-750-1A
W/CHANGE 3

4. Failure criteria. A device which exhibits arc-overs, harmful coronas, or any other defect or deterioration that may interfere with the operation of the device shall be considered a failure.

5. Summary. The following conditions must be specified in the applicable performance specification sheet or acquisition document:

- a. Maximum pressure (see 3).
- b. Voltage (see 3.b).

Attachment 2

Discussion of Barometric Pressure Test Bias Conditions

IR Hi Rel
1/24/2022

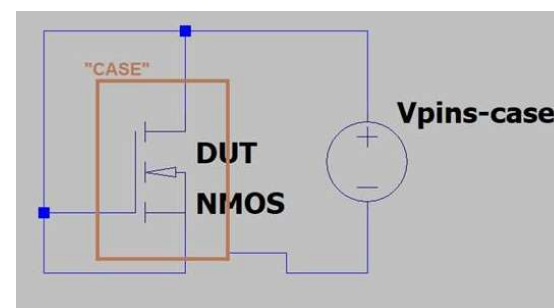
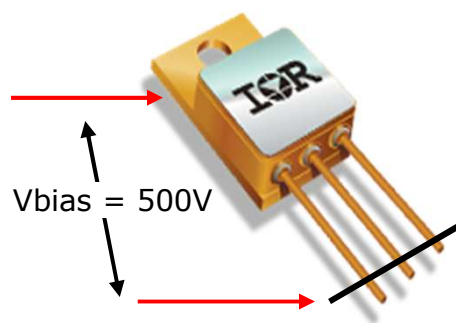
IOR HiRel
An Infineon Technologies Company

Introduction

- › A team at IR HiRel in Leominster, MA has been evaluating the interpretation of the bias condition requirements of MIL-STD-750 method 1001.4 for Barometric Pressure (Reduced)
- › Current IR HI Rel procedure defines bias application in the manner of a package isolation test – i.e. bias applied between the package metal case as one node, and all leads connected together as the other node.
- › Observation of some recent test results in T0-254 package led to investigation and consideration of the optimal means of applying bias to devices under test to meet intent of Method 1001, and provide most benefit to the user.

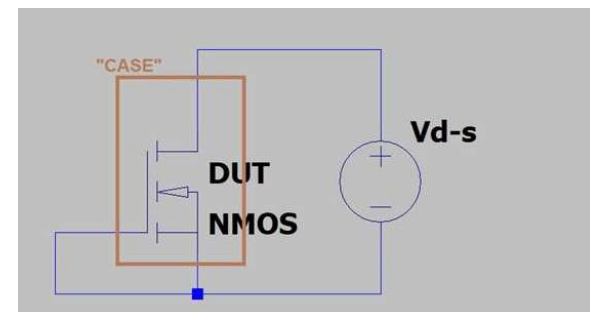
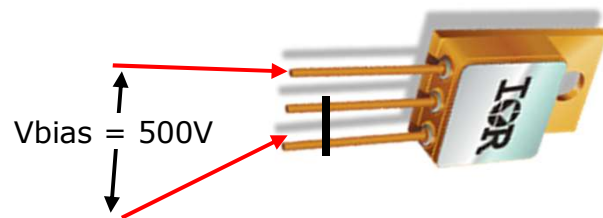
Example of recent test performed on T0-254 package

- › A set of test samples was subjected to a Barometric Pressure test at 500V.
- › For the initial run of the test, Bias was applied between case and leads.
- › Failures were identified at Vacuum levels >30 Torr (~1.2 Inches Hg); expectation is that devices will not show electrical leakage at vacuum levels well below 30 Torr.



Example of recent test performed on T0-254 package

- › Test was re-run with bias applied between the Drain and Source of the device (Gate shorted to Source)
 - › All samples passed at levels below 10 Torr.



Example of test performed on T0-254 package

- › The results of the testing on the T0-254 test were consistent with other earlier results, in which T0-254 samples were unable to meet barometric test conditions when bias was applied between case and “all leads connected together”
 - › These results generated discussion about what the proper method was for applying bias, since device in use will see max bias condition when applied between Drain and Source.
- › When the test was performed with bias between Drain and Source, the devices were easily able to meet leakage current expectations at vacuum representing 70,000 feet (condition C of method 1001.4)

Other package configurations

- › For non-isolated metal packages, like TO-3 or TO-39, where the case comprises the drain connection, the VD-S bias must be the applied condition.



- › For ceramic-lidded SMD packages, such as SMD 0.2C, 0.5C, the bias can only be applied between VD-S as there is no case connection.



Review of test conditions identified on existing 19500 slash sheets

- › For all devices with a $BV_{dss} \geq 250 \text{ V}$, 19500 slash sheets were reviewed, to determine what Barometric Pressure requirements were identified.
- › In all cases where the QCI tables identified conditions for Barometric pressure bias, the condition stated that V_{DS} was the applicable condition.

Interpretation of the intent of MIL-STD-750

- › With respect to the application of electrical bias to the test samples, there are several statements included in MIL-STD-750 method 1001.4:
- › In section 1:
 - ...This test is intended primarily to determine the ability of component parts and materials to avoid **dielectric-withstanding-voltage failures** due to the lowered insulating strength of air and other insulating materials at reduced pressures. Even when low pressures do not produce complete electrical breakdown, corona and its undesirable effects, including losses and ionization, are intensified.
- › In section 3:
 - If not specified in the applicable performance specification sheet or acquisition sheet, the device shall be subjected to the **maximum voltage under rated conditions**.
- › Thus it can be seen there are, in the same method, a purpose to assess dielectric withstanding voltage failures, and a desire to subject the device to maximum rated voltage under rated conditions – which we interpret to relate to the actual max device application bias- for example BVdss for a MOSFET.
- › In actual testing, a device which passes the VDS bias test at atmospheric pressure and then fails this test at low pressure is failing due to dielectric withstanding failures.

Input from industry

- › As part of our investigation, we engaged in discussion with several customer and user representatives.
 - › The result of these discussions:
 - › In general, the user community acknowledged the reference to the dielectric withstanding voltage performance in the methods' purpose statement.
 - › The user community also recognized the benefit of applying a D-S bias during the barometric pressure test, because this was a better approximation or the worst case bias when the component was installed in next level assembly.

Other standards:

- › MIL-STD-883 method 1001:

With respect to the application of electrical bias to the test samples, there are several statements included in MIL-STD-883 method 1001:

- › In section 1:

- ...This test is intended primarily to determine the ability of component parts and materials to avoid **voltage breakdown failures** due to the reduced dielectric strength of air and other insulating materials at reduced pressures. Even when low pressures do not produce complete electrical breakdown, corona and its undesirable effects, including losses and ionization are intensified...

- › In section 3:

- ...The device shall have the specified voltage applied....

- › MIL-STD-202 method 105:

- › In section 1.1:

- ...This test is intended primarily to determine the ability of component parts and materials to avoid **dielectric-withstanding-voltage failures** due to the lowered insulating strength of air and other insulating materials at reduced pressures.

IR Hi Rel proposal

- › After a review of the requirements of MIL-STD-750 method 1001.4 and discussion with the user community, IR proposal is to proceed with updates to our internal test procedure:
- › When applying bias to samples for the purpose of reduced barometric pressure testing, the bias shall be applied as follows:
 - › For MOSFET, apply the max rated BVDss between Drain and Source (gate shorted to Source)
 - › For diode, apply the max rated reverse bias between diode cathode and anode.
- › Justification:
 - › This method is consistent with section 3 of method 1001.4, in that it represents the worst case maximum voltage under dated conditions.
 - › In cases where existing IR HiRel product 19500 slash sheets define the bias conditions, the definition is for VDS bias.



IOR HiRel
An Infineon Technologies Company